

This RFI submission is provided by the Boulder Space Alliance. The Boulder Space Alliance is comprised of the Cooperative Institute for Research in Environmental Sciences (CIRES), the Laboratory for Atmospheric and Space Physics (LASP), the University Corporation for Atmospheric Research (UCAR), and Ball Aerospace & Technologies Corp.

Dr. Waleed Abdalati  
Director  
Cooperative Institute for Research in Environmental Sciences  
University of Colorado at Boulder

Dr. Daniel Baker  
Director  
The Laboratory for Atmospheric and Space Physics  
University of Colorado at Boulder

Dr. Thomas Bogdan  
President  
University Corporation for Atmospheric Research  
Boulder, CO

Mr. Robert Strain  
President  
Ball Aerospace & Technologies Corp.  
Boulder, CO

**Questions from 2013 OSTP RFI corresponding to submitted answers (listed following questions):**

- Q1. Are the 12 SBAs listed above sufficiently comprehensive? a. should additional SBAs be considered, b. should any SBA be eliminated.
- Q2. Are there alternative methods for categorizing Earth observations that would help the U.S. government routinely evaluate the sufficiency of Earth observation systems.
- Q3. What management, procurement, development, and operational approaches should the U.S. Government employ to adequately support sustained observations for services, sustained observations for research, and experimental observations? What is the best ratio of support among these areas?
- Q4. How should the U.S. Government ensure the continuity of key Earth observations, and for which data streams (*e.g.*, weather forecasting, land surface change analysis, sea level monitoring, climate-change research)?
- Q5. Are there scientific and technological advances that the U.S. Government should consider integrating into its portfolio of systems that will make Earth observations more efficient, accurate, or economical? If so, please elaborate.
- Q6. How can the U.S. Government improve the spatial and temporal resolution, sample density, and geographic coverage of its Earth observation networks with cost-effective, innovative new approaches?

- Q7. Are there management or organizational improvements that the U.S. Government should consider that will make Earth observation more efficient or economical
- Q8. Can advances in information and data management technologies enable coordinated observing and the integration of observations from multiple U.S. Government Earth observation platforms?
- Q9. What policies and procedures should the U.S. Government consider to ensure that its Earth observation data and information products are fully discoverable, accessible, and useable?
- Q11. What types of public-private partnerships should the U.S. Government consider to address current gaps in Earth observation data coverage and enhance the full and open exchange of Earth observation data for national and global applications?
- Q12. What types of interagency and international agreements can and should be pursued for these same purposes?

### **Boulder Space Alliance Responses to Questions Posed:**

**Question 1:** The SBAs identified are sufficiently comprehensive, and we would not recommend the elimination of any. We note that the 12 SBAs identified in the list are not entirely separable. For example, "Disasters" (SBA #4) can often be closely associated with severe events such as those in the "Weather" domain (SBA #12) or the "Space Weather" domain (SBA #9). Thus, in keeping with the expressed tone of the RFI, it is imperative to bear in mind the **systems** approach to observing the highly coupled Sun-Earth elements. Moreover, by addressing SBA requirements in an integrated way, it will undoubtedly be possible to devise observing tools and platforms that can meet multiple objectives in effective and natural ways. This can reduce costs and greatly increase robustness.

**Question #2:** Methods of categorizing are not as important as developing standards for success. The SBAs provide a reasonable vehicle for doing this, but the appropriateness of the observing system will depend on what the needs in each area are. Whatever categorization is used, threshold and desired objectives must be defined (and prioritized) against which the suitability of the observing system can be assessed.

**Question #3:** The U. S. Government (USG) should adopt a policy that ensures: (a) all available payload capacity is used, developing a program that establishes a queue of instruments that are available for launch on any excess capacity basis; this could be facilitated by developing a standard interface for small payloads. (b) operational sensors (and their associated data management) are of such a quality that they can be used to support research efforts, and (c) a robust assessment of the need for sustained observations for research is made - similar to assessments for weather observational needs - and that planning for such observations is an integral part of the overall observational strategy. Currently, there is a challenge for supporting missions requiring sustained observations that are neither operational nor experimental, such as solar irradiance monitoring in support of climate research or space weather monitoring.

**Question #4:** The U. S. Government (USG) should maintain primary responsibility for a core operational satellite Civil Earth Observation backbone, for key infrastructure support of services protecting life and property in the short-term, and ensure we develop an observational and knowledge base that positions the U.S. to be successful in the face of long-term changes in our environment that affect health and security. Such a solution for Earth observations would resemble the solutions currently in place for military communications satellites and imagery solutions, where the USG maintains a core capability that is augmented with commercial solutions. In addition the USG requires strategic Earth observations for critical policy decision and national security with regard to climate change. Maintaining the critical long-term climate records as a key observational element is critical. Since commercial value is limited for climate monitoring data the USG will need to continue in its role as provider of the observational assets to obtain these data.

**Question #5:** For critical Earth Observations there is a need to constantly innovate on both the science and technological aspects. The USG should maintain the key role of investing in basic and applied research to ensure the U.S. maintains its role as world leader in technology development by providing the impetus to push forward new developments under NASA to support science programs. These science and technology developments incubate new ideas and provide the risk reductions necessary to transition those innovations into the improved observational strategies and possible private sector investment. A good example of USG investment in technology development is provided by NASA's Earth Science Technology Office (ESTO) which has invested in technologies for more than a decade, thereby successfully advancing Earth Observation capabilities to support new missions. The USG should focus some investment on reducing the cost of access to space, and developing capabilities for robust Earth observation using small satellites (whose capabilities can be measured against the criteria identified through question 2). While small satellites do not have the same capability as larger satellites and cannot replace all observations collected by large satellite-based missions, the tight budget constraints resulting in diminishing Earth observation capability motivate consideration of small satellite solutions as a means to reduce costs for observations suited to acquisition from small satellites. Doing so would provide an option in the architecture toolkit that would allow the continuation of important scientific observations that are well-suited to the smaller satellite capabilities and could enable the collection of existing or new Earth observations that might not otherwise be gathered due to budgetary constraints. In this way, through the appropriate tailoring of system architectures employing satellite sizes ranging from cube satellites to large Aqua-style satellites across the Earth observation portfolio, it should be possible to conduct more Earth observations within the same budget.

**Question #6:** Improvements in spatial and temporal sampling of space-based observations could be realized by deploying multiple small satellites (or cubesats) as opposed to fewer larger observatories. These small satellites could be carbon copies of one another, which would make their production in quantities greater than one relatively cost-effective, and their light weight could reduce their launch costs, by allowing them to occupy excess capacity on

existing launches, or if multiple copies could be deployed by a single small launch vehicle. While there has been talk of such an approach, without the commitment to sustained observations analogous to weather satellites, such an approach has not and will not be realized. When a commitment to the observations is made, an approach can be optimized, as opposed to having competitions for one-off versions of differing sensors.

**Question #7:** By developing a long-term observing strategy that identifies sustained non-operational observations to which the USG will commit, multiple copies of systems could be built, lowering the per-mission cost, in much the same way the Defense Meteorological Satellite Program works. The savings could then be used to invest in technologies to lower the cost or improve the coverage of subsequent observatories.

**Question #8:** The decline in Earth observing assets makes it critical that we maximize the use of the data that we do collect, which includes making advances in information and data management technologies. This is only part of the solution, however. There must be a commitment to sustained data management; It would be helpful to take a longer term view of data management that moves towards a stable and sustained funding approach that would allow the development of more robust infrastructures. It is important to increase the connections among data products produced by the different agencies (NASA, NOAA, NSF) to increase the use and usability of data by the broadest range of investigators possible. Toward that end, data management technologies are most useful when equal attention is paid to metadata, both in terms of content and standards, as it is the metadata that allows users to find the data they want. Finally, the training of scientists in data management practices (including the value of good metadata) is important, so that the data they collect (e.g., ground truth data) can be used to the maximum extent and as broadly as possible.

**Question #9:** The use of standard formats for similar data sets (e.g. satellite data sets), will lower the barriers to use and discovery. This can be achieved for more complex types of data with a central set of repositories, similar to the Distributed Active Archive Centers (DAAC's) that NASA uses, along with an investment in infrastructure that supports these repositories. A continued and widely publicized policy of open access to data (to the extent that national interests are not negatively impacted is also very important. Furthermore, a standard research to operations transition process (that includes operations playing a role in establishing mission requirements) across civilian agencies needs to be promulgated such that the latest research improvements can be incorporated quickly and seamlessly into civilian operational missions. The Department of Defense has an established research to operations process that funds basic, and applied research in a spectrum approach that leads to testing evaluation and eventual fielding of technologies. The civilian side of the government would benefit from a similarly rigorous system to support fielding of observational systems that are proven during development to meet research and operational needs.

**Question #11:** It is possible that data services solutions with the USG as the sole tenant in a public-private partnership will provide more cost effective solutions over typical satellite acquisition approaches. In this way, the full and open exchange of Earth observation data for

global applications can continue unabated despite a transition from traditional USG-acquired systems requiring exceptional USG resources to monitor the acquisition process to USG acquisition of data services, where the USG verifies the veracity of the data and pays a subscription fee according to the value received from those data. Critical to this approach is a long-term commitment with a data provider for extended value data sets such as climate and land use data.

**Question # 12:** International agreements to share results from science missions should be encouraged, but in all areas where the acquired information are essential to national and economic security interests and strategic policy issues (e.g. weather observations and long-term climate data sets) the USG should maintain a core capability owned by the United States rather than rely solely upon international agreements. At the same time, it is important to recognize that Earth observations developed by USG programs are part of a broader international system of observing capabilities. The optimum USG observing approach is one that occurs within the framework of the Global Earth Observation System of Systems (GEOSS). As such, the USG should avoid duplication of other nations' efforts and target the greatest needs in the context of the international framework. For systems that are key to national and economic security interests, it is essential that the USG maintain resilience in the systems to ensure the existence of a resilient program with plentiful spare hardware, allowing the United States to maintain system performance in the face of hardware failures; this is particularly important due to the vulnerability of space assets and the long lead times required to replace satellites in the event of launch vehicle or satellite failures. Finally, International agreements that are established should require open data policies of our foreign partners, allowing access to data in the same way that U.S. data are accessible to our foreign collaborators. Restrictive data policies inhibit the use of data from any source (that does not threaten any nation's security) inhibit the advancement of science, and inhibit the realization of the value of the data and associated investments.